

EFFECT OF IRRIGATION REGIMES AND LATERAL SPACING ON DRIP IRRIGATED WHEAT

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ABSTRACT

Wheat is one of the important cereal crops grown all over the world as well as in India. Due to its importance as a cereal crop and main leading staple food, determination of optimum water requirement through drip irrigation which is function of soil crop and atmosphere is needed for achieving more crop production and higher productivity per unit of water. Keeping in view, a field experiment was undertaken to access the conjugate effect of three irrigation regimes (0.6 IW/CPE, 0.8 IW/CPE and 1.0 IW/CPE) and three lateral spacing (0.60 m, 0.80 m and 1.0 m) on productivity of wheat. Split plot design with three replications was adopted. Drip irrigation with 0.6 m lateral spacing and 1.0 IW/CPE ratio resulted higher grain yield, plant height, straw yield, harvest index and 1000 grain weight of 4298 kg/ha, 94.2 cm, 6249 kg/ha, 40.89 and 46.56 gm respectively. Highest water use efficiency (11.75 kg/ha.mm) was observed at 0.6 IW/CPE with 0.60 m lateral spacing.

KEYWORDS: *Wheat, Drip Irrigation, Irrigation Regimes, Lateral Spacing & Water Use Efficiency*

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INTRODUCTION

Improvement of irrigation water management in agriculture, which is the biggest water consumer, is necessary to enhance agricultural productivity in order to meet food demands of the growing population. Water demand is significantly increased over the last decades. While available water resources are becoming increasingly scarce. A study by the International Water Management Institute (IWMI) shows that around 50% of the increase in demand for water by the year 2025 can be met by increasing the effectiveness of irrigation¹.

The major problem associated with decreasing amount of fresh water for irrigation is conveyance losses, reducing the net utilization of irrigation water to 46 % only. With increasing demand of irrigation water, the irrigation efficiency and water use efficiency can be enhanced by replacing surface irrigation with micro irrigation methods like drip irrigation especially in arid and semi-arid region.

Wheat (*Triticum aestivum* L.) is a cereal grain, originally from the Levant regions of the near East but now cultivated worldwide and contributes 27 % of total cereal production. India stands 2nd both in area 29.65 Mha and production 94.6 MT with average productivity of 3 tons per hectare in the world. India's share in world wheat area is about 12.5 % whereas it occupies 12 % share in the total world wheat production. With predicted world population of 9.3 billion by 2050, the demand for wheat is expected to increase by 60 % compared with 2010 (FAO). To meet this demand a major research effort is needed to increase wheat production and sustainability.

Presently in India, most of area under wheat crop is irrigated by border irrigation, with very poor water

use efficiency of about 66.5%² because of huge conveyance and distribution losses^{3, 4}. Now a days rising water consumption in industries and urban areas makes irrigation water for agriculture under threat. A variation in yield of wheat is observed from year to year depending upon the availability of limited available water for irrigation. Today total sowing area of wheat vary with rainfall condition in monsoon. In good rainfall year total area under wheat will be more.

Drip irrigation can be practiced successfully to irrigate wide range of crop variety especially in vegetables, orchard crops, flowers and plantation crops but on the other hand, limited studies had been conducted under field crops like wheat. Drip irrigation saves more than 20 percent of irrigation water⁵ as compare to surface irrigation in wheat crop, and for producing 1 kg of wheat about 1000 lit of irrigation water is required⁶. Applicability and success of drip irrigation changes with soil type, climate and management of system of irrigation and hence it has to be tested for region specific.

Only few studies had been focused carried out for the feasibility of the alternative drip irrigation systems (surface and subsurface drip); for the intensive field crop conditions, which had been carried out by⁷⁻¹⁰. The adoption of drip irrigation in wheat crop could also reduce water consumption. This could helpful in irrigation water saving and contributes to increase staple food production in the future. Therefore, this study has the priority on the effect of lateral spacing and irrigation regimes on wheat crop yields in clay loam soils of Indian agriculture.

MATERIALS AND METHODS

To achieve the objectives of this study, a field experiment was carried out during the winter (rabi) seasons of 2015–16 at Instruction Farm of the College of Agricultural Engineering and Technology, Junagadh Agricultural University, Junagadh, Gujarat, India. Research site lies between latitude 21.50 N and 70.10 E. The study area was having typically subtropical and semi-arid, annual average temperature was 26.70 °C and average annual rainfall of the area was 936 mm. the soil textural class of the study area was clay with contain clay 41.19%, silt 26.92% and sand 31.88%. Wheat (GW-496) was sown on 28th November 2015 by the tractor drawn seed cum fertilizer seed drill at a seed rate of 120 kg/ha and 22.5 cm row spacing. Recommended fertilizer dose 120:60:60 of N: P: K was applied to the crop, as basal dose 60:60:60 of N:P:K was applied at the time of sowing and remaining N was applied 21 days from sowing. Wheat was harvested on 13th March 2016. The experiment was undertaken to evaluate three drip irrigation regimes (0.6 IW/CPE, 0.8 IW/CPE and 1.0 IW/CPE) and three lateral spacing (0.60 m, 0.80 m and 1.0 m) on cumin. Split plot design was adopted and treatments were replicated thrice. Electric submersible motor was used as a pressurized water source from tube well for drip irrigation system. Main line of size 75 mm and sub main line of size 50 mm both made of PVC delivered irrigation water through LDPE laterals of 16 mm outer diameter with 9 m length and inline drippers with discharge of 4 lph with 60 cm lateral spacing at 1.0 bar operating pressure were used. Irrigation frequency was kept as 4 days. The digital USB evaporation pan was installed in the field to monitor the daily evaporation adjoining to the field which is given in figure 1.

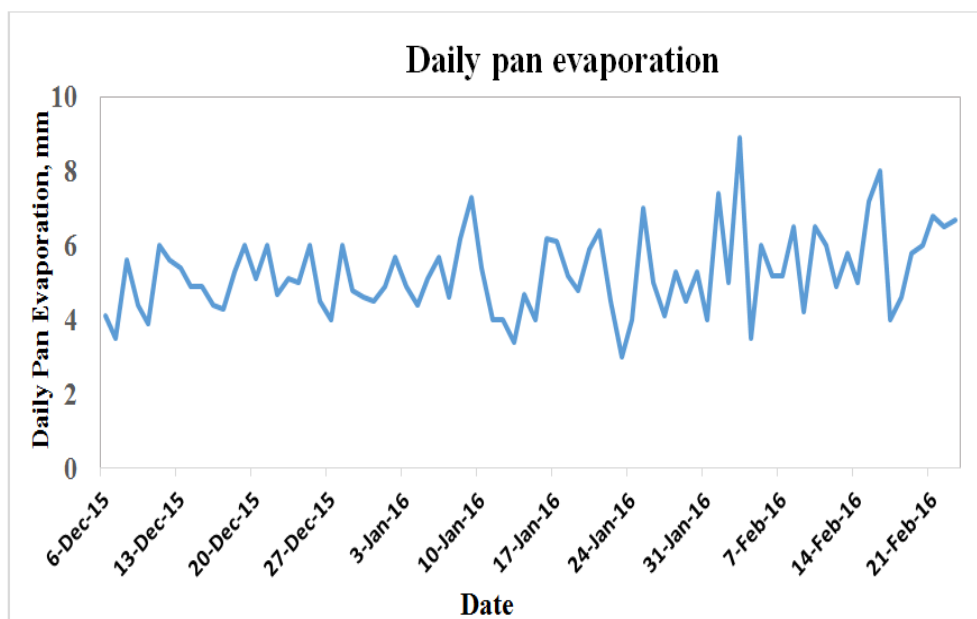


Figure 1: Daily Pan Evaporation Data

Table 1: Physiochemical Properties of the Soil of Experimental Field

Sr. No.	Particular	Values
A	Physical Properties	
1	Sand (%)	31.88
2	Silt (%)	26.92
3	Clay (%)	41.19
4	Textural class	Clay
5	Field Capacity (%)	23.77
6	Dry bulk density (g/cm ³)	1.51
7	Infiltration rate (cm/h)	1.00
8	Porosity (%)	42.00
9	Specific Gravity	2.50
10	Voids Ratio	0.73
B	Chemical Properties	
1	Organic carbon (%)	0.55
2	pH (1:2.5)	8.85
3	EC(1:2.5) (dS/m)	0.30
4	Nitrogen (kg/ha)	256.0
5	Phosphorous (P ₂ O ₅) (kg/ha)	30.0
6	Potash (K ₂ O) (kg/ha)	290.0

RESULTS AND DISCUSSIONS

Effect of irrigation regimes and lateral spacing were analysed mainly using Plant height, yield and yield attributes of wheat crop and WUE. Daily evaporation during the experimental period for 2015-16 years is shown in Figure 1. The cumulative evaporation during 2015-16 was observed to be 469.4 mm.

Yield and Yield Attributes

The combined effect of irrigation regimes and lateral spacing was observed on the plant height, grain yield, straw yield, harvest index and 1000 grain weight of wheat and is depicted in Table 2. The results revealed that there was significant difference in plant height, grain yield, straw yield, harvest index and 1000 grain weight due to interaction effect

of irrigation regimes and lateral spacing. Plant height, grain yield and straw yield increased with increase the IW/CPE ratio from 0.6 to 1.0. But, decreased with increase the lateral spacing from 0.6 m to 1.0 m. This may be due to water stress between two laterals with increased lateral spacing. Lowest plant height, grain yield and straw yield was observed at 0.6 IW/CPE due to insufficient availability of water than the required to the crop. Highest plant height (94.2 cm), grain yield (4298 kg/ha), dry matter yield (6249 kg/ha), Harvest Index (40.89) and 1000 grain weight (46.56 gm) were observed at 1.0 IW/CPE ratio for 0.60 m lateral spacing. Highest plant height, grain yield and straw yield were observed at a lateral spacing of 0.60 m. Under closer lateral spacing better prevalence of soil moisture, enhanced microbial activity which in turn enhanced the grain yield of wheat. Availability of uniform moisture in soil during growing season increased growth of plant. Water Use Efficiency is the quantity (kg) of wheat grain production/ha.mm of water utilized under different treatments. The data on water use efficiency shown in Table 2. Data shows that I_1S_1 gave higher water use efficiency of 11.75 kg/ha-mm than other treatment, lowest water use efficiency of 7.18 kg/ha-mm was found under I_1S_3 . Water use efficiency values decreased with increasing water use and lateral spacing. At 0.6 IW/CPE and 0.6 m lateral spacing, uniform water distribution was obtained due of which more water was available in the root zone, due of which increased grain yield and yield attributes. Treatment I_3S_1 (0.6 m lateral spacing and 1.0 IW/CPE) can be suggested for areas with limited water resources.

Table 2: Effect of Different Treatment Combination on Wheat Morphological Parameters

Treatment		Irrigation Ratio	Lateral Spacing (m)	Plant Height (cm)	Grain Yield (kg/ha)	Straw Yield (kg/ha)	Harvest Index (%)	1000 Grain Weight (gm)	Water use Efficiency (kg/ha-mm)
T1	$I_1 S_1$	0.6 IW/CPE	0.6	83.6	3548	5467	39.36	40.16	11.75
T2	$I_1 S_2$	0.6 IW/CPE	0.8	83.2	3174	4919	39.22	39.50	10.51
T3	$I_1 S_3$	0.6 IW/CPE	1.0	75.2	2169	3429	38.74	35.46	7.18
T4	$I_2 S_1$	0.8 IW/CPE	0.6	91.6	3903	5779	40.71	43.00	10.11
T5	$I_2 S_2$	0.8 IW/CPE	0.8	89.1	3733	5356	40.42	41.58	9.67
T6	$I_2 S_3$	0.8 IW/CPE	1.0	79.0	2975	4411	40.36	38.51	7.70
T7	$I_3 S_1$	1.0 IW/CPE	0.6	94.2	4298	6249	40.89	46.56	9.14
T8	$I_3 S_2$	1.0 IW/CPE	0.8	90.8	3989	5786	40.80	42.40	8.48
T9	$I_3 S_3$	1.0 IW/CPE	1.0	80.5	3449	4996	40.75	39.46	7.33
S. Em. $\pm$				0.77	86.37	126.39	0.09	0.55	
C.D. at 5%				2.37	266.15	389.48	0.07	1.68	

CONCLUSIONS

Being an important cereal crop, staple food and more water demanding crop water saving methods needs to implement in the wheat. So attempts have been made in the present research work to identify water management strategies in the crop with productive and efficient irrigation systems. Effect of irrigation regimes and lateral spacing on wheat was evaluated in terms of yield and yield attributes. Drip irrigation with 0.6 m lateral spacing and 1.0 IW/CPE ratio resulted higher grain yield, plant height, straw yield, harvest index and 1000 grain weight of 4298 kg/ha, 94.2 cm, 6249 kg/ha, 40.89 and 46.56 gm respectively. Highest water use efficiency (11.75 kg/ha.mm) was observed at 0.6 IW/CPE with 0.60 m lateral spacing. Considering the performance of drip irrigation system at 0.6 m lateral spacing and 1.0 IW/CPE irrigation level which gave higher grain yield, straw yield and yield attributes, this combination may be adopted for wheat cultivation under drip irrigation for increasing the farmers' income.

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